

Part IV. Plant Assessment Form

For use with “Criteria for Categorizing Invasive Non-Native Plants that Threaten Colorado’s Wildlands,
Economy, and Ecology”
By the Colorado Noxious Weed Advisory Committee

Electronic version, March 28, 2007

Table 1. Species and Evaluator Information

Species name (Latin binomial):	Alliaria petiolata [Bieb.] Cavara & Grande
Synonyms:	Alliaria alliaria, A. officinalis, Erysimum alliaria, Sisymbrium alliaria
Common names:	Garlic mustard, Garlic root, Garlicwort, hedge-garlic, Jack-by-the-hedge, Jack-in-the-bush, Mustard root, poor-man's-mustard, sauce-alone
Evaluation date (mm/dd/yy):	08.04.2008
Evaluator #1 Name/Title:	Stephanie Danyi, IPM Crew Leader
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Section below for list committee use—please leave blank

List committee members:	enter text here
Committee review date:	enter text here
List date:	enter text here
Re-evaluation date(s):	enter text here

General comments on this assessment:

This garlic mustard assessment is based on literature and site visits to garlic mustard locations in Boulder, Colorado Springs, and Bear Creek Lake Park, Lakewood.

Table 2. Criteria, Section, and Overall Scores

1.1	Impact on abiotic ecosystem processes	C	Rev'd, Sci. Pub'n
1.2	Impact on plant community	A	Rev'd, Sci. Pub'n
1.3	Impact on higher trophic levels	C	Rev'd, Sci. Pub'n
1.4	Impact on genetic integrity	U	No Information

Impact
<i>Enter four characters from Q1.1-1.4 below:</i>
CACU
<i>Using matrix, determine score and enter below:</i>
B

2.1	Role of anthropogenic and natural disturbance	B (2 pts)	Other Pub. Mat'l
2.2	Local rate of spread with no management	A (3 pts)	Rev'd, Sci. Pub'n
2.3	Recent trend in total area infested within state	B (2 pts)	Observational
2.4	Innate reproductive potential Wksht A	A (3 pts)	Rev'd, Sci. Pub'n
2.5	Potential for human-caused dispersal	B (2 pts)	Other Pub. Mat'l
2.6	Potential for natural long-distance dispersal	B (2 pts)	Other Pub. Mat'l
2.7	Other regions invaded	A (3 pts)	Other Pub. Mat'l

Invasiveness
<i>Enter the sum total of all points for Q2.1-2.7 below:</i>
17
<i>Use matrix to determine score and enter below:</i>
A

Plant Score
<i>Using matrix, determine Overall Score and Alert Status from the three section scores and enter below:</i>
Medium
Alert Status

3.1	Ecological amplitude/Range	D	Other Pub. Mat'l
3.2	Distribution/Peak frequency Wksht C	U	Anecdotal

Distribution
<i>Using matrix, determine score and enter below:</i>
D

4.1	Poisonous to livestock	D	Rev'd, Sci. Pub'n
4.2	Detrimental to economic crops	D	Other Pub. Mat'l

4.3	Detrimental to management of agricultural system, rangeland and pasture	U	No Information
4.4	Human health impacts	D	Rev'd, Sci. Pub'n
4.5	Impact to property values	U	No Information
4.6	Impact to recreational values	D	Rev'd, Sci. Pub'n
4.7	Economic value of species/impact of listing to industry	U	No Information

Table 3. Documentation

Question 1.1 Impact on abiotic ecosystem processes	C Rev'd, Sci. Pub'n
<p>Identify ecosystem processes impacted:</p> <p>Field studies showed that nutrients N, P, Ca and Mg availability, and soil pH were significantly higher in areas invaded by <i>A. petiolata</i>, however no difference was observed in lab and greenhouse experiments.</p> <p>Presence of <i>A. petiolata</i> leaf litter significantly increased the decomposition rate of native leaf litter.</p>	
Rationale: enter text here	
<p>Sources of information:</p> <p>Rodgers, Vikki L., B.E. Wolfe, L.K. Werden, and A. Finzi. 2008. The invasive species <i>Alliaria petiolata</i> (garlic mustard) increases soil nutrient availability in northern hardwood-conifer forests. <i>Oecologia</i>. 157(3): 459-471.</p>	
Question 1.2 Impact on plant community composition, structure, and interactions	A Rev'd, Sci. Pub'n
<p>Identify type of impact or alteration:</p> <ol style="list-style-type: none"> 1. Can shade out spring ephemerals and early summer forbs. (Thought I read they are very competitive not only for light, but for water and nutrients, have you seen anything on this) 2. Can outcompete some woody species, especially those requiring arbuscular mycorrhizal fungi mutualisms. 3. Alters the environment that allows for further colonization of <i>A. petiolata</i> and decreased competitive ability in native species. 4. Creates monotypic stands. 	
<p>Rationale:</p> <ol style="list-style-type: none"> 1. <i>A. petiolata</i> achieves maximum rates of photosynthesis earlier in the growing season than many indigenous plants. 2. Able to outcompete <i>Quercus pinus</i>, a woody perennial. 3A. Disrupts arbuscular mycorrhizal fungi mutualisms with native plants, causing inhibited growth. This could cause a shift in community composition. 3B. Has allelochemical compounds that could inhibit growth of native plants. <p>(Add information on invasion and changing intact forest understory communities out east, if available. At this point I would have to say we are looking at a B ranking).</p> <ol style="list-style-type: none"> 4. Seedlings densities of 830-1800/m² have been observed in central Illinois and up to 20,000/m² in Ohio. 5. Several Boulder Colorado infestations are monotypic stands of varying sized, ranging from .001 to > 1 acre. Infestations in Rhode Island and Indiana were monotypic stands of varying size some much over 1 acre. 	
<p>Sources of information:</p> <ol style="list-style-type: none"> 1. Myers, C.V., and R. C. Anderson. 2003. Seasonal Variation in Photosynthetic Rates Influences Success of an Invasive Plant, Garlic Mustard (<i>Alliaria petiolata</i>). <i>American Midland Naturalist</i> 150(2): 231-245. 2. Meekins, J.F., and B.C. McCarthy. 1999. Competitive Ability of <i>Alliaria petiolata</i> (Garlic Mustard, Brassicaceae), an Invasive, Nonindigenous Forest Herb. <i>Int. J. Plant Sci.</i> 160(4):743-752. 	

<p>3A. Stinson, K.A., Campbell S.A., Powell J.R., Wolfe, B.E., Callaway R.M., et al. 2006. Invasive plant suppresses the growth of native tree seedlings by disrupting belowground mutualisms. PLoS Biol 4(5): e140. DOI: 10.1371/journal.pbio.0040140</p> <p>3B. Vaughn, S.F. 1999. Allelochemicals isolated from tissues of the invasive weed garlic mustard (<i>Alliaria petiolata</i>). J. Chem. Ecol. 25(11):2495-2504</p> <p>4. Anderson, R.C., T.C. Kelley, and S.S. Dhillon. 1996. Aspects of the ecology of an invasive plant, garlic mustard (<i>Alliaria petiolata</i>), in central Illinois. Restoration Ecology 4:181-191.</p> <p>4. Trimbur, T.J. 1973. An ecological life history of <i>Alliaria officinalis</i>, a deciduous forest "weed". M.S. thesis. Ohio State University. 56 pp.</p> <p>5. Eric Fairlee, IPM Coordinator. City of Boulder Open Space and Mountain Parks. Personal observations. 8/18/2008.</p>	
Question 1.3 Impact on higher trophic levels	C Rev'd, Sci. Pub'n
<p>Identify type of impact or alteration:</p> <p>Presence of garlic mustard interferes with oviposition of the rare native butterflies <i>Pieris napi</i> leucocroceae Harris and <i>Pieris virginiensis</i> W. H. Edwards (Lepidoptera: Pieridae). Eggs laid by females hatch but larvae are unable to complete development on garlic mustard.</p>	
<p>Rationale: Garlic mustard is acting as a population sink for these species, but it is unknown by the assessors whether this is a potential problem for Colorado.</p>	
<p>Sources of information:</p> <p>Porter, A. 1994. Implications of introduced garlic mustard (<i>Alliaria petiolata</i>) in the habitat of <i>Pieris virginiensis</i> (Pieridae). Journal of the Lepidopterists' Society. 48(2): 171-172.</p> <p>Haribal-Meena and J.A.A. Renwick. 1998. Isovitexin 6"-O-beta-D-glucopyranoside: A feeding deterrent to <i>Pieris napi</i> oleracea from <i>Alliaria petiolata</i>. Phytochemistry. 47(7): 1237-1240.</p> <p>Huang, X.P., Renwick, J.A.A., and Chew, F.S. 1994. Oviposition stimulants and deterrents control acceptance of <i>Alliaria petiolata</i> by <i>Pieris rapae</i> and <i>P. napi</i> oleracea. Chemoecology. 5 / 6(2): 79.</p>	
Question 1.4 Impact on genetic integrity	U No Information
<p>Identify impacts: enter text here</p>	
<p>Rationale: enter text here</p>	
<p>Sources of information: enter text here</p>	
Question 2.1 Role of anthropogenic and natural disturbance in establishment	B Other Pub. Mat'l
<p>Describe role of disturbance:</p> <p><i>A. petiolata</i> populations on average will double in size every four years. However with disturbances, including flooding and windstorms, the population can grow 10 times as large in that same time.</p>	

Rationale: Garlic mustard does not need disturbance to establish or spread, but spreads faster with both natural and anthropogenic disturbances.	
Sources of information: Nuzzo, V.A. 1992. Garlic mustard (<i>Alliaria petiolata</i> [Bieb.] Cavara and Grande) rate of spread and potential impact on groundlayer species. Report to the Illinois Department of Conservation. Native Landscapes. 17 p.	
Question 2.2 Local rate of spread with no management	A Rev'd, Sci. Pub'n
Describe rate of spread: Question 2.1 as well. 1. <i>A. petiolata</i> can become established & spread in high quality forest ecosystems	
Rationale: 1.A. <i>petiolata</i> has been shown to spread at an average rate of 5.6 m per year in high quality forests with little disturbance. 1.B. Colonization of a site by <i>A. petiolata</i> is not dependant on patches of bare soil created by disturbance and is capable of invading sites with an intact litter layer.	
Sources of information: 1 Nuzzo, V. 1999. Invasion pattern of the herb garlic mustard (<i>Alliaria petiolata</i>) in high quality forests. <i>Biol. Invasions</i> 1(2-3): 169-179 1B. Meekins, J.F. and B.C. McCarthy. 2001. Effect of Environmental Variation on the Invasive Success of a Nonindigenous Forest Herb. <i>Ecological Applications</i> 11(5):1336-13348.	
Question 2.3 Recent trend in total area infested within state	B Observational
Describe trend: The total area infested has not been categorized. In the known areas where management has begun in Boulder, the total area infested has increased since 2006.	
Rationale: enter text here	
Sources of information: Eric Fairlee, IPM Coordinator. City of Boulder, Open Space and Mountain Parks. personal observation. 8/18/2008	
Question 2.4 Innate reproductive potential	A Rev'd, Sci. Pub'n
Describe key reproductive characteristics: 1. Number of seeds produced per plant, the seed mass and germination timing of the seeds are all highly plastic allowing the plant to take advantage of a wide range of growing conditions. 2. <i>A. petiolata</i> is self-compatible, with high fecundity (5,000-20,000 seeds/meter squared) and viability (greater than 95%). The seed bank lasts from 1-5 years. 3. Autogamy is the most likely breeding system.	

<p>Rationale:</p> <ol style="list-style-type: none"> 1. Seed mass is highly variable. Seed mass also influences time till germination and growth patterns of the resulting plant. 3. Pollination and stigma receptivity occur before the flower is open. 	
<p>Sources of information:</p> <ol style="list-style-type: none"> 1. Susko, D.J. and L. Lovett-Doust. 2000. Patterns of seed mass variation and their effects on seedling traits in <i>Alliaria petiolata</i> (Brassicaceae). <i>American Journal of Botany</i>. 87:56-66. 2. McCarthy, B. 2002. The Ecology of Garlic Mustard in Eastern Hardwood Forests. <i>Proceedings:2002 U.S. Department of Agriculture Interagency Research Forum</i>. p 67-68. 3. Anderson, Roger C.; Dhillon, Shivcharn S.; Kelley, Timothy M. 1996. Aspects of the ecology of an invasive plant, garlic mustard (<i>Alliaria petiolata</i>), in central Illinois. <i>Restoration Ecology</i>. 4(2): 181-191. 	
Question 2.5 Potential for human-caused dispersal	B Other Pub. Mat'l
<p>Identify dispersal mechanisms:</p> <p><i>Alliaria petiolata</i> seeds generally fall within a few meters of the plant. The seeds embedded in the soil can then be easily spread by hikers on muddy boots or in pant cuffs.</p> <p>Seed dispersal may also be facilitated by roadside mowing, as well as on mud-encrusted automobile tires.</p> <p>Seeds may float and can potentially be transported along irrigation systems.</p>	
<p>Rationale: enter text here</p>	
<p>Sources of information:</p> <p>Munger, Gregory T. 2001. <i>Alliaria petiolata</i>. In: <i>Fire Effects Information System</i>, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (Producer). Available: http://www.fs.fed.us/database/feis/ [2007, August 14].</p> <p>Trimbur, J Thomas. 1973. <i>An Ecological Life History of Alliaria Officinalis A Deciduous Forest "Weed"</i>. MS Thesis. 56pp.</p>	
Question 2.6 Potential for natural long-distance dispersal	B Other Pub. Mat'l
<p>Identify dispersal mechanisms:</p> <ol style="list-style-type: none"> 1. <i>Alliaria petiolata</i> often grows along streams and it's dispersal may be facilitated by moving water, allowing it to travel quickly along riparian corridors. 1. Animals, especially white-tailed deer, may promote seed dispersal and spread of garlic mustard by transporting seeds in their fur or hooves. Foraging deer may also create microsite disturbances favorable to garlic mustard dispersal by mixing mineral soil and garlic mustard seeds. 	
<p>Rationale: 1 and 2. Seeds may float which allows for downstream movement.</p>	

<p>Sources of information: 1. Munger, Gregory T. 2001. <i>Alliaria petiolata</i>. In: Fire Effects Information System, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (Producer). Available: http://www.fs.fed.us/database/feis/ [2007, August 14].</p> <p>2. Trimbur, J Thomas. 1973. An Ecological Life History of <i>Alliaria Officinalis</i> A Deciduous Forest "Weed". MS Thesis. 56pp.</p>	
Question 2.7 Other regions invaded	A Other Pub. Mat'l
<p>Identify other regions:</p> <p>1. <i>A. petiolata</i> is present in the following states in the USA: AK, AR, CO, CT, DC, DE, GA, IA, ID, IL, IN, KS, KY, MA, MD, ME, MI, MN, MO, NC, ND, NE, NH, NJ, NY, OH, OK, OR, PA, SC, TN, UT, VA, VT, WA, WI, and WV. In Canada it is found in: BC, NB, NS, ON, QC.</p> <p>2A. Here is a list of the states which have made a classification for garlic mustard: Alabama: Class A noxious weed, Connecticut: Invasive, banned, Massachusetts: Prohibited, Minnesota: Prohibited noxious weed, New Hampshire: Prohibited invasive Species, Oregon: "B" designated weed, Quarantine, Vermont: Class B noxious weed, Washington: Class A noxious weed, Noxious weed seed and plant quarantine.</p> <p>2B. Illinois, Indiana, Missouri, and Wisconsin have developed vegetation management guidelines for <i>Alliaria petiolata</i>.</p> <p>2C. Canada lists <i>Alliaria petiolata</i> as one of four principal invasive aliens in upland habitats</p> <p>3. In the eastern U.S., garlic mustard occurs in the understory of a variety deciduous forests and woodlands including Oak savannas, eastern prairies, xeric upland eastern deciduous forests, lowland eastern deciduous forests, along the agriculture/forest edge, and in flood plains. In Canada is has been reported to grow in areas with conifers.</p> <p>4. In Summit County, UT, Park City Mountain Resort, garlic mustard is found one the north side of hills in the openings within douglas fir-white fir forests associated with the Park City Mountain Resort. Garlic mustard is also present in small patches and isolated plants in the mountain brush community (oak, Utah serviceberry, and snowberry community) and aspen groves adjacent to ski runs. As in Colorado, garlic mustard is found in monotypic stands under crack willow in drainages. The elevation of these infestations ranges between 6,500 and 7,200 feet.</p>	
<p>Rationale: Garlic mustard has invaded multiple ecotypes throughout the nation and some of these ecotypes are present in Colorado.</p>	
<p>Sources of information:</p> <p>1 & 2A. U.S. Department of Agriculture, National Resource Conservation Service. 2008. PLANTS database (2008), [Online]. Available: http://plants.usda.gov/.</p> <p>2B. Nuzzo, Victoria. (2000). Element stewardship abstract: <i>Alliaria petiolata</i> (<i>Alliaria officinalis</i>): garlic mustard. In: Weeds on the web: The Nature Conservancy wildland invasive species program, [Online]. Available: http://tncweeds.ucdavis.edu/esadocs/documnts/allipet.pdf [2008, August 18].</p> <p>2C. White, D.J., E. Haber and C. Keddy. 1993. Invasive plants of natural habitats in Canada. Canadian Museum of Nature. Ottawa, Canada. 121 p.</p> <p>3. Munger, Gregory T. 2001. <i>Alliaria petiolata</i>. In: Fire Effects Information System, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (Producer). Available: http://www.fs.fed.us/database/feis/ [2007, August 14].</p> <p>4. Mindy Wheeler, Summit County, UT Cooperative Weed Management Coordinator. Personal communication.</p>	

8/18/2008.	
Question 3.1 Ecological amplitude/Range	D Other Pub. Mat'l
Describe ecological amplitude, identifying date of source information and approximate date of introduction to the state, if known:	
<p>1. In North America, <i>A. petiolata</i> was first recorded on Long Island, New York in 1868, thought to have been brought in from Europe for use as a medicinal/garden plant.</p> <p>2 & 3. In the 1950's <i>A. petiolata</i> was collected in Colorado Springs, on the grounds of the Broadmoor Hotel. By 1995 it was dominant and possibly considered invasive along Fountain Creek.</p> <p>4. Present in Boulder, Colorado Springs, and Lakewood in riparian corridors.</p>	
Rationale: 4. Comprehensive mapping has not been done for this species in Colorado. Mapping in Boulder has only been done while searching for other riparian species and during treatment events for garlic mustard in known locations. The ecological amplitude/range is incompletely known in the state for this reason, however, a minimum of a D ranking is still warranted based on known infestations in riparian areas.	
Sources of information:	
<p>1. Nuzzo, Victoria A. 1993. Current and historic distribution of garlic mustard (<i>Alliaria petiolata</i>) in Illinois. The Michigan Botanist. 32(1): 23-33</p> <p>2. Weber, W.A. and R.C. Wittmann. 1996. Colorado flora: eastern slope. 2nd ed. Niwot, CO: University Press of Colorado. p. 126</p> <p>3. CU Herbarium Collections. http://cumuseum.colorado.edu/Research/Botany/Databases/search.php [Online 2008, August 18]</p> <p>4. Eric Fairlee, IPM Coordinator. City of Boulder Open Space and Mountain Parks. Personal communication. 8/18/2008.</p>	
Question 3.2 Distribution/Peak frequency	U Anecdotal
Describe distribution:	
Total distribution unknown, likely to be common along riparian corridors throughout the front range.	
Rationale: Based on observations in Colorado Springs, Lakewood, and Boulder.	
Sources of information: Eric Fairlee, IPM Coordinator. City of Boulder Open Space and Mountain Parks. Personal communication. 8/18/2008.	
Question 4.1 Poisonous to Livestock	D Rev'd, Sci. Pub'n
Describe impacts in terms of high probability of death, long-term health impacts, or short-term health impacts: Garlic mustard is apparently palatable to livestock, however it is thought to taint the flavor of milk in dairy cattle.	
Rationale: enter text here	

Sources of information: Cavers, Paul B.; Heagy, Muriel I.; Kokron, Robert F. 1979. The biology of Canadian weeds. 35. <i>Alliaria petiolata</i> (M. Bieb.) Cavara and Grande. Canadian Journal of Plant Science. 59(1): 217-229.	
Question 4.2 Detrimental to Economic Crops	D Other Pub. Mat'l
Describe impacts to all aspects of cropping systems (see guidelines): Has been observed growing in wheat and soybean fields.	
Rationale: enter text here	
Sources of information: Scott, D.R. 2000. Aspects of the ecology of Garlic Mustard, <i>Alliaria Petiolata</i> (BIEB) Cavara and Grande, in Ohio. PhD. Dissertation. Ohio State University. 188 p.	
Question 4.3 Detrimental to Mgmt of Agricultural System, Rangeland and Pasture	U No Information
Describe impacts to water diversion systems, increased water use, reduced forage for livestock: enter text here	
Rationale: enter text here	
Sources of information: enter text here	
Question 4.4 Human Health Impacts	D Rev'd, Sci. Pub'n
Describe features such as irritants (sap), spines, poisonous, and smoke impacts: There are no negative health impacts from this plant, infact it is high in Vitamin A and Vitamin C and can be eaten as a salad green.	
Rationale: Vitamin A content (8,600 units/100g in young leaves, 19,000 in basal leaves) and Vitamin C content (190mg/100g in young leaves), both substantially higher than levels in commercially grown fruits and vegetables.	
Sources of information: Zennie, T.M. and C.D. Ogzewalla. 1977. Ascorbic acid and vitamin A content of edible wild plants of Ohio and Kentucky. Economic Botany 31:76-79.	
Question 4.5 Impact to Property Values	U No Information
Describe impacts such as decreased value of land for crop and/or forage production, and/or increased risk of fire: enter text here	
Rationale: enter text here	

Sources of information: enter text here	
Question 4.6 Impact to Recreational Values	D Rev'd, Sci. Pub'n
Identify decreased value of land for camping, biking, boating, and other recreational uses; e.g., tamarisk makes it more difficult for people to use shoreline for camping and fishing): Presence of <i>A. petiolata</i> could have a negative impact on early season wildflower viewing.	
Rationale: <i>A. petiolata</i> significantly decreases species richness and composition of spring ephemerals and some woody perennials.	
Sources of information: Cavers, Paul B.; Heagy, Muriel I.; Kokron, Robert F. 1979. The biology of Canadian weeds. 35. <i>Alliaria petiolata</i> (M. Bieb.) Cavara and Grande. Canadian Journal of Plant Science. 59(1): 217-229. Stinson, K., S. Kaufman, L. Durhin and F. Lowenstein. 2007. Impacts of Garlic Mustard Invasion on a Forest Understory Community. Northeastern Naturalist. 14(1):73-88	
Question 4.7 Economic Value of Species/ Impact of Listing to Industry	U No Information
Describe financial impacts to agriculture, horticulture and/or nursery, seeds: enter text here	
Rationale: enter text here	
Sources of information: enter text here	

Worksheet A

Reaches reproductive maturity in 2 years or less	Yes: 1 pt
Dense infestations produce >1,000 viable seed per square meter	Yes: 2 pts
Populations of this species produce seeds every year.	Yes: 1 pt
Seed production sustained over 3 or more months within a population annually	No: 0 pt
Seeds remain viable in soil for three or more years	Yes: 2 pts
Viable seed produced with <i>both</i> self-pollination and cross-pollination	Yes: 1 pt
Has quickly spreading vegetative structures (rhizomes, roots, etc.) that may root at nodes	No: 0 pt
Fragments easily and fragments can become established elsewhere	No: 0 pts
Resprouts readily when cut, grazed, or burned	Yes: 1 pt
8 pts	Total Unknowns

A (6+ pts)

Note any related traits: While seed set has been mostly completed by the end of June, limited flowering has been observed at the end of July (Eric Fairlee, personal observations, 2008).
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Worksheet B - Colorado Ecological Types and Land Use

(*sensu* Holland 1986)

Major Ecological and Land Use Types	Minor Ecological and Land Use Types	Code*
Freshwater and Aquatic Systems	lakes, ponds, reservoirs	Unknown
	rivers, streams, canals	Unknown
Riparian and wetlands	Riparian forest	C. 5-20%
	Riparian shrublands	Unknown
	Wet meadows	Unknown
Grasslands	Shortgrass prairie	Unknown
	Tallgrass prairie	Unknown
	Sandsage prairie	Unknown
	Montane meadows	Unknown
Irrigated Agriculture	Hay meadows	Unknown
	Irrigated crops (alfalfa, corn, sugar beets)	Unknown
Dryland Agriculture	Dryland crops (wheat, corn, millet, dryland grass hay, sunflowers, mustard for biodiesel)	Unknown
Developed Lands	Urban, exurban, industrial	Unknown
Arid Shrublands	Sagebrush shrublands	Unknown
	Foothills shrublands	Unknown
	Gambel oak shrublands	Unknown
Woodlands	Pinyon - juniper	Unknown
	Ponderosa pine	Unknown
	Limber pine	Unknown
Forest	Lodgepole pine	Unknown
	Spruce-fir	Unknown
Alpine	Boulder and rock fields	Unknown
	Dwarf shrublands	Unknown
	Tundra	Unknown
Barrens (lower elevation)	Dunes	Unknown
	Rock outcrops	Unknown
	Canyonlands	Unknown

* A. means >50% of type occurrences are invaded; B means >20% to 50%; C. means >5% to 20%; D. means present but ≤5%; U. means unknown (unable to estimate percentage of occurrences invaded).